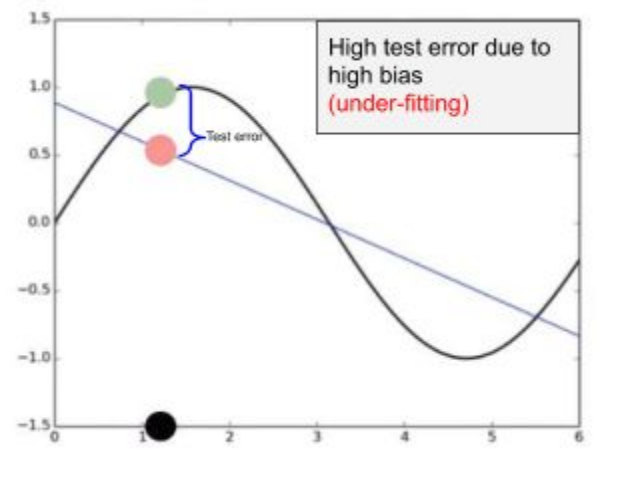
PadhAI: Regularization

One Fourth Labs

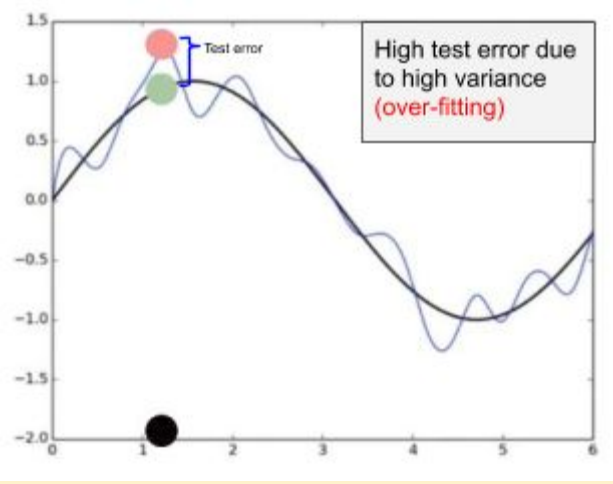
Test error due to high bias and high variance

What is the effect of high bias and high variance on the test error

1. So far, we have been analysing the performance of the models on training data, and determining if they were high/low bias/variance
   a. The Simple Model failed miserably on the training data, with a very high error/loss value
   b. The Complex Model however performed extremely well. Though it did deviate the sine-function (true curve), it was still able to fit all the training points, scoring a very low error/loss value
2. Let's look at how it performs on the test dataset
3. Consider the simple model
   a. Let's look at a visualisation of the test set predictions

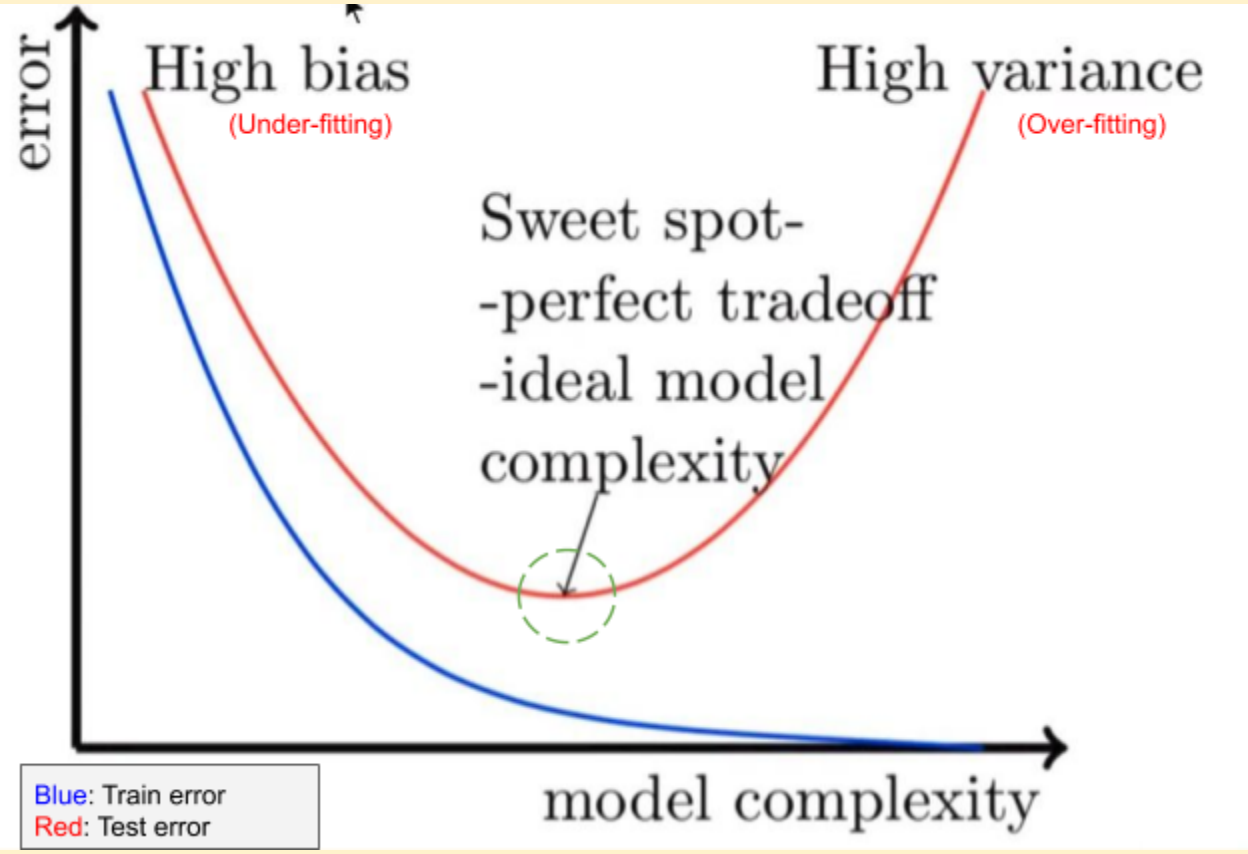


   b. Here, the high bias model does poorly on the test set. This is understandable as the model performed poorly on the test set, so it was never very likely to perform well on the test set
4. Consider the complex model
   a. Let's look at a visualisation of the test set predictions



   b. Here, the high variance model also shows a high test error, unlike its test set performance. This is because the model over-familiarised itself with the training set, to the point that it was unable to successfully predict new points from the test set.

5. Let us look at how training and test error vary with model complexity



6. From the above figure, we can make the following observations
   a. For simpler/high-bias models, the training and test error are both very high. This is because the model has not adjusted in accordance with the inputs given. It can be said that the model is under-fitting.
   b. For complex/high-variance models, the training error is low but the test error is high. This is because the model has adjusted too much to the training inputs given, thereby not being able to predict any new points well. It can be said that the model is overfitting.
   c. The sweet-spot of model-complexity is the perfect trade-off between bias and variance. It is characterised by low training and test error.